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Study of energy fluctuation effect on the statistical mechanics of equilibrium systems

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Abstract

This work is devoted to the modeling of energy fluctuation effect on the behavior of small classical thermodynamic systems. It is known that when an equilibrium system gets smaller and smaller, one of the major quantities that becomes more and more uncertain is its internal energy. These increasing fluctuations can considerably modify the original statistics. The present model considers the effect of such energy fluctuations and is based on an overlapping between the Boltzmann-Gibbs statistics and the statistics of the fluctuation. Within this "overlap statistics", we studied the effects of several types of energy fluctuations on the probability distribution, internal energy and heat capacity. It was shown that the fluctuations can considerably change the temperature dependence of internal energy and heat capacity in the low energy range and at low temperatures. Particularly, it was found that, due to the lower energy limit of the systems, the fluctuations reduce the probability for the low energy states close to the lowest energy and increase the total average energy. This energy increasing is larger for lower temperatures, making negative heat capacity possible for this case.

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